

# PATENT SPECIFICATION

DRAWINGS ATTACHED

1095,127



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## COMPLETE SPECIFICATION

### Diaphragm Type Pressure Regulating Valve

We, ESSO RESEARCH AND ENGINEERING COMPANY, a Corporation duly organised and existing under the laws of the State of Delaware, United States of America, of Elizabeth, New Jersey, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a diaphragm type pressure regulating valve. It relates more particularly to a balanced diaphragm type valve basically controlled by pneumatic back pressure in which hydraulic as well as pneumatic pressure is employed to operate the valve or to keep the diaphragm in balance.

The invention is particularly applicable to fluid pressure control systems employing automatic pressure actuated valves of the type wherein a valve element is moved into or out of its seat according to the pressure applied by the moving fluid to the diaphragm. Such devices are widely used as safety valves and for pressure regulating valves.

More particularly, the present invention is a diaphragm type pressure regulating valve comprising a first chamber for receiving fluid and delivering fluid, a second chamber for loading the pressure in said first chamber having a main and a subsidiary compartment, a diaphragm dividing said first and second chambers, a valve adapted to seat on a fluid delivery port in said first chamber, said valve attached by stem to said diaphragm, and to move responsive to movement of the diaphragm, an inlet for the introduction of hydraulic fluid into the main compartment of said second chamber and means for varying the pressure of air or other gas in the subsidiary compartment of said second chamber. The valve can be removed from its seat on appli-

cation of sufficient pressure to the diaphragm which thereby controls the flow through the outlet. 45

The invention also provides a method of controlling the pressure loading on the diaphragm of a valve wherein the second chamber is filled with air or other gas, wherein hydraulic fluid is introduced into the said second chamber to provide a predetermined loading, the introduction of the hydraulic fluid causing the said air or other gas to be compressed in said main and in said subsidiary compartments and adjusting the pressure in said subsidiary compartments. 50 55

Diaphragm valves, controlled by pneumatic back pressure, are of course, well known in the art. The present invention operates on the same general principle. According to the invention, a second chamber is provided on the side of the diaphragm opposite the flowing fluid which is to be pressure controlled. In the present case, however, the second chamber is supplemented by a system for adjusting the pressure on the diaphragm without requiring a major source of pneumatic pressure. In particular, the second chamber has added to it a means for injecting into the chamber a liquid of suitable composition under suitable pressure. This liquid, being substantially incompressible, is employed to vary the effective volume of the second chamber. The liquid may be any appropriate liquid, such as water or oil. This system serves to make large step adjustments in the effective back pressure of the valve diaphragm. Means are provided also for making small adjustments in pressure, aside from the hydraulic means. By reason of its construction, the regulating valve can be operated without an outside source of pressurized gas such as is usually required in prior art valves of this type. 60 65 70 75 80 85

As noted above, pressure regulators in the

prior art have been operated hitherto with pressurized gas on the back or opposite sides of the diaphragm from the fluid passing through the regulator. In many cases such devices have been entirely satisfactory. However, such valves, of the type with which this invention is concerned, have normally required elaborate and costly compressing equipment, or else have required particular and frequently expensive supplies of compressed gas for the back pressure. Whenever flow conditions are to be changed, back pressure gas must be added or vented. The gases used in such valves frequently must be pumped from remote locations at considerable expense and trouble.

A particular object of the present invention, then, is to make it possible to apply a variable control pressure on the back side of the diaphragm, i.e. opposite the flowing gas or other fluid, in such a way that the operating pressure at the outlet of the valve can be readily changed or adjusted to any desired value without recourse to an outside source of pressurized control gas. For example, the regulating pressure may be changed by simply adjusting the volume of gas in the dome or the compartment behind the diaphragm. This is accomplished in turn by (1) applying liquid pressure stepwise to the second back pressure compartment and (2) by finer adjustments being secured by mechanical operations which further adjust to the desired degree of accuracy the volume of the pressurized gas. All these operations are accomplished without sacrificing the inherent good quantities of the gas or pneumatic cushion which backs up the diaphragm.

A main disadvantage of prior gas type regulating valves is that when adjusting the pressure it is often difficult to get precisely the desired back pressure. Adjustments are made by introducing or releasing a suitable volume of gas under pressure. The desired volume is often overshoot or undershot. This makes it difficult to set such a valve with accuracy. With the present arrangement such over or under adjustments are much less likely to happen. A particular object of this invention is to avoid overshooting or undershooting the desired pressure by facilitating more accurate adjustments.

The invention will be more fully understood by reference to specific embodiments which will next be described in connection with the accompanying drawings which form a part of this specification.

Referring to the drawings, Figure 1 shows a vertical sectional view through a preferred embodiment wherein a mechanical fine volume adjustment means is added to a hydraulic supplement pressure means to apply the desired pressure to a gas cushion for back pressuring a pressure reducing valve.

Figure 2 is a vertical sectional view through

a modification of a generally similar type wherein pneumatic pressure is adjusted roughly by injection of hydraulic fluid and more finely by an alternative means for changing the pressure on the pneumatic gas itself.

Referring first to Figure 1, there is shown a pressure regulating valve body of a more or less standard type, having a lower compartment casing 11, an upper casing 13 and appropriate means for holding these parts together, such as bolts 15. Between the lower sections is clamped a flexible diaphragm 17. This is held or sealed, e.g. by gaskets, not shown, in such a manner that no gas or liquid can escape along its edges. The lower valve body or compartment 11 is equipped with an inlet line 21 for the inflowing gas, and an outlet line 23 where the fluid exits. The outlet line 23 connects to a valve seat opening 25. Valve 25 is adapted to be closed by the valve element 27 attached to a depending stem 29 which is secured to the diaphragm 17. Obviously, flexing of the diaphragm will open or close the valve.

The upper half of the valve body 13 is provided with a cavity 31 of substantial volume, to which is connected a hydraulic fluid line 33. By this means, hydraulic fluid may be pumped into the compartment or cavity 31 against the diaphragm to raise to any desired level, for example to the level indicated by line 35. Above line 35 is a smaller pneumatic compartment 37, ordinarily filled with a compressible fluid such as air or other appropriate gas, such as nitrogen and the like. Injection of hydraulic fluid obviously places the gas under suitable pressure within compartment 37. Compartment 37 may be quite small compared with compartment 31, or it may be more or less equal in size in some cases.

Compartment 37 also can be adjusted in volume *per se*, with as fine an adjustment as desired because it consists of or comprises a screw threaded cylindrical chamber having walls 39 into which a screw plug 41 may be turned to any desired depth.

Obviously, when gas is flowing in through line 21 pressure builds up on the lower side of diaphragm 17 until the latter yields and lifts the valve 27 off its seat 25. Thereupon the gas can flow out through line 23. The point at which diaphragm 17 yields to lift the valve off its seat is controlled by the back pressure on the diaphragm, as will be obvious to those skilled in the art. Assume that before the valve is adjusted it contains no hydraulic liquid, the pneumatic fluid in compartment 37 will then fill the entire chamber 37 and 31 at relatively low pressure. As hydraulic liquid is injected through line 33, the pneumatic fluid is compressed and is driven upwardly into the upper part of the chamber, as indicated in the drawing. As

soon as the approximate desired pressure is obtained, the hydraulic pump is stopped.

The hydraulic fluid coming through line 33 may be pumped in by a manual pump or by any other means. It may be fed in from a source of hydraulic liquid under pressure. In any case, hydraulic liquid is forced in until the total pressure behind or above the diaphragm 17 reaches approximately the desired level. Finer adjustments may then be made by turning screw 41 in or out to get the exact back pressure desired.

In Figure 2, a generally similar arrangement is shown wherein the lower valve body or compartment 111 is provided with an inlet line 121 and an outlet line 123. A valve 127 is arranged to rest on valve seat 125, being suspended by a stem 129 from diaphragm 117.

The upper part of back pressure compartment of the valve body is indicated at 113. It is secured to the lower valve body, with the diaphragm clamped between them, by means of suitable fastening, such as screws 115. As in the case of Figure 1, the apparatus can be brought to approximately the desired back pressure by injecting hydraulic liquids through the line 133. However, since it is usually desirable to make fine adjustments in the back pressure which cannot readily be accomplished by the injection of hydraulic fluid through line 133, additional pressure adjustment means are provided.

Accordingly, a supplemental means is provided consisting of a small cylinder 150, containing a piston 151 suitably actuated by a piston rod 152. The latter may be manually operated or operated mechanically, as desired. By moving the piston 151 in or out, the pneumatic pressure in compartment 137 is accurately adjustable. Conventional means, not shown, will be provided for locking the piston in adjusted position.

The cylinder 150 connects to the chamber 137 in the upper part of the member 113 through a conduit 154. A valve 155 of appropriate type is shown in this conduit so that the pressure in the chamber 137 may be adjusted as desired, to an exact value, whereupon the valve 155 may close and the system remains at the desired back pressure until it is intentionally changed. The valve 155 can be omitted if the piston is secured in selected position.

It will be obvious that various modifications may be made in the valve and that means such as bellows may be substituted for the pump 150, 151. Alternatively, such a pump or bellow may be combined with a mechanical threaded volume changing screw

member such as 41 of Figure 1. That is to say that various means for changing the volume of the pneumatic fluid to a major degree and additional means for changing the pressure of the pneumatic fluid by small adjustments in the volume and/or pressure may be used.

The essence of the invention is the use of hydraulic pressure for major adjustments in back pressure with fine adjusting means being provided independent of the hydraulic system for varying the volume and/or pressure of the pneumatic zone of the back pressure chamber.

#### WHAT WE CLAIM IS:—

1. A diaphragm type pressure valve comprising a first chamber for receiving fluid and delivering fluid, a second chamber for loading the pressure in said first chamber having a main and a subsidiary compartment, a diaphragm dividing said first and second chambers, a valve adapted to seat on a fluid delivery port in said first chamber, said valve attached by a stem to said diaphragm, and to move responsive to movement of the diaphragm, an inlet for the introduction of hydraulic fluid into the main compartment of said second chamber and means for varying the pressure of air or other gas in the subsidiary compartment of said second chamber.
2. A pressure regulating valve according to claim 1 wherein the said second chamber is provided with means movable inwards or outwards to vary the volume of the said second chamber.
3. A pressure regulating valve according to claim 1 or claim 2 wherein the pressure within the pneumatic chamber is adjusted by changing the amount of pneumatic gas therein.
4. A pressure regulating valve according to claim 2 or claim 3 wherein the said means movable inwards or outwards comprises a threaded screw plug which can be adjusted in or out.
5. A pressure regulating valve according to claim 2 or claim 3 wherein said means movable inwards or outwards is a pump.
6. The method of controlling the pressure loading on the diaphragm of a valve as claimed in claim 1 wherein the said second chamber is filled with air or other gas, wherein hydraulic fluid is introduced into the said second chamber to provide a predetermined loading, the introduction of the hydraulic fluid causing the said air or other gas to be compressed in said main and in said subsidiary compartments and adjusting the pressure in said subsidiary compartments.

7. A diaphragm type pressure regulating valve substantially as described herein with reference to the accompanying drawings.

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FIG. 1.

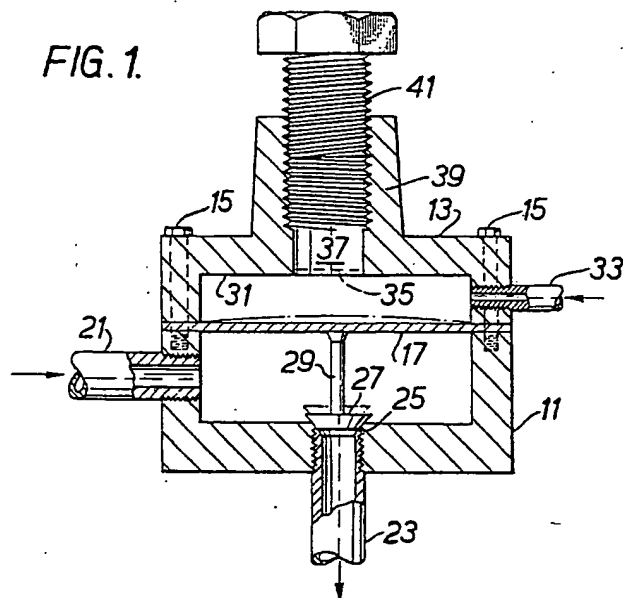


FIG. 2.

